Acanthogorgia coccinea, Verrill.

Nepthya coccinea, Stimpson, *l. c.* 1855.

Hong-Kong, 10 fathoms, on shells. Dr. Wm. Stimpson.

Veretillum Stimpsonii, Verrill.

A large species, 6 or 8 inches long, the upper portion enlarged, more than half the entire length. Polyps much exsert, upwards of an inch long; tentacles very long. Axis thick, short, fusiform, a third of an inch long. Base white, somewhat striated; body light cream-colour; polyps transparent, bluish white at the bases of the tentacles.

Hong-Kong, 6–10 fathoms, mud. Dr. Wm. Stimpson.

Veretillum baculatum, Verrill.

Club-shaped, the base about a third of the length. Polyps scattered, not numerous. Axis small, fusiform, about half an inch long in a specimen 3 inches long.

Sea of Ochotsk, off Siberia. L. M. Squires.

Kophobelemnon clavatum, Verrill.

Veretillum clavatum, Stimpson, *l. c.* 1855.

Polyps more numerous and crowded than in *K. Burgeri*, Herkl., which it resembles; body more claviform, naked dorsal space very narrow.

Hong-Kong, 6 fathoms, mud. Dr. Wm. Stimpson.

PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL SOCIETY.

June 15, 1865.—Major-General Sabine, President, in the Chair.

"On the Anatomy and Physiology of the Nematoids, parasitic and free; with observations on their Zoological Position and Affinities to the Echinoderms." By Henry Charlton Bastian, M.A., M.B. (Lond.), F.L.S.

After commenting upon the many conflicting statements which have been made concerning the anatomy of these animals, and more especially with regard to the presence or absence of a nervous system, and of real organs of circulation, the author alludes to the increased interest which has lately been thrown over this order by the discovery of so many new species of the non-parasitic forms, marine, land, and freshwater.

He has entered fully into the description of the tegumentary organs, and has recognized a distinct cellulo-granular layer intervening between the great longitudinal muscles and the external chiti-

nous portion of the integument. This layer is one of great importance in the economy of these animals; the author looks upon it as the deep formative portion of the integument, from which the chitinous lamellæ are successively excreted. It is bounded internally by a fibrous membrane, which serves as an aponeurosis for the attachment of the four great longitudinal muscles; and the well-known lateral and median lines which have so long been a puzzle to anatomists are, he says, in reality nothing more than intermuscular developments of this layer. In some species each of the lateral lines contains an axial vessel, though in very many others nothing of this kind is to be met with. A periodical ecdysis of the chitinous portion of the integument takes place in all Nematoids during the period of their growth.

The author agrees with Dr. Schneider as to the nature of the transverse fibres attached to the median lines. They are contractile prolongations from the longitudinal muscles, and may be considered extrinsic muscles for the propulsion of the intestinal contents, since the intestine itself has no muscular tissue in its walls.

Schneider's description of the nervous system in *Ascaris megalocephala* has been confirmed, and a similar arrangement has been recognized by the author in several other Nematoids. It exists as a nervous ring encircling the commencement of the œsophagus, in connexion with many large ganglion-cells. The principal peripheral branches are given off from the anterior part of the ring, and proceed to the region of the mouth and cephalic papillæ. Although well developed ocelli exist in many of the free marine species, no nerve-filaments have yet been detected in connexion with them.

The organs of digestion are mostly simple, the principal variations being met with in the presence or absence of a pharyngeal cavity, and in the structure of the œsophagus. In some species its parietes are distinctly muscular, whilst in others, as in the *Trichocephali* and *Trichosomata*, they are as distinctly cellular. Those possessing a pharyngeal cavity sometimes have well-marked tooth-like processes developed from its walls; but the author believes that the chitinous plates which are sometimes met with in posterior swellings of the œsophagus are not "gastric teeth," as they have been hitherto described, but rather valvular plates for ensuring greater perfection in the suctorial process by which these animals pass their food along this portion of the alimentary canal.

The water-vascular system may be seen in many Nematoids in its most elementary condition, as a small tubular gland, with an excretory orifice in the mid-ventral region of the anterior part of the body. In other Nematoids no trace of such a system exists; whilst its most developed condition yet recognized in these animals may be seen in *Ascaris osculata* and *A. spiculigera*, where an intimate plexus of vessels, still in connexion with an anterior ventral pore, is met with in a peculiar development from the left lateral band. Intermediate conditions between these extreme forms may be traced in other species; and from the obviously glandular nature of the tubular or pyriform organ met with so commonly in the free, and also in many

of the parasitic species, he thinks considerable light is thrown upon the function of the "water-vascular" system. He says, "Here we have undoubtedly to deal with an excretory glandular apparatus. No one could for a moment regard these structures as at all analogous to vessels destined alternately to receive and discharge an external fluid medium. I believe that in the *Trematoda* and *Tæniada* also, where similar though often more developed systems exist, their function is in like manner one of a purely eliminatory kind; and I therefore cannot but look upon the name of 'water-vascular' apparatus as a singularly inappropriate appellation for this system of vessels."

Other very peculiar transverse vessels exist in the deep integumental layer of *Ascaris megalocephala* and *A. lumbricoides*, mostly running in pairs from median line to median line, and, strangely enough, being about twice as numerous on the right as on the left side of the body.

The author believes that in the Nematoids but little provision exists for the oxidating portion of the process of respiration, and thinks that this deficiency may be compensated by a greatly increased activity of glandular *eliminating* organs. Considering the conditions under whose influence so many of the parasitic forms pass their existence, we can easily imagine that the presence of any organs for effecting an oxidation of their tissues would not only be useless, but actually baneful. Glandular organs exist in the greatest abundance in all Nematoids, and many of these are excretory organs. In those species in which no modification of the ventral excretory apparatus is met with, the author has found a very large number of channels running through the chitinous portion of the integument, so as to bring its deep cellular layer into communication with the exterior. These pores are, he believes, complementary respiratory organs, and their development is always in an inverse proportion to that of the other excretory organs. Thus amongst the free Nematoids he has found them most numerous in *Dorylaimus stagnalis* and *Leptosomatum figuratum*—species in which the ventral excretory apparatus is entirely absent. The same arrangement is met with in the *Trichocephali* and *Trichosomata*, in which these integumental channels attain their maximum development. The gradually widening longitudinal band long known to exist in the *Trichocephali* is due to the presence of thousands of these channels in connexion with a glandular development of the deep integumental layer beneath.

Many interesting facts are brought forward concerning the "tenacity of life" of some of the free Nematoids, and their power of recovery after prolonged periods of desiccation. This has been long known as one of the characteristics of *Tylenchus tritici**, but the author has found it common only to the species of four land and freshwater genera—*Tylenchus, Plectus, Aphelenchus*, and *Cephalobus*. The remainder of the free Nematoids are remarkably frail, and incapable of recovering even after the shortest periods of desiccation.

* *Vibrio tritici* of older writers.

In the last section, on "The zoological position and affinities of the Nematoids," the author enters fully into what he believes to be the points of resemblance between these animals and the Echinoderms. The strongest evidence is, he thinks, to be found in the fact of the very close resemblance between the nervous systems of these animals, differing notably as they do at the same time from what we find in the *Scolecida* or *Annelida*. Then the integumental pores which he has now discovered in so many Nematoids can, he thinks, be paralleled only by the ambulacral and other pores met with in the Echinoderms. Great similarities in the distribution of these pores may also be observed in the two groups. The Nematoids present no trace of segmentation or lateral appendages to their bodies, but traces of a radiate structure do exist. Their various parts and organs exhibit a quadrate mixed with a ternate type of development. He looks upon the order *Nematoidea* as an aberrant division of the class *Echinodermata*, which at the same time tends to connect this class in the most interesting manner with the *Scolecida*—since, although in the points above mentioned they display their affinities to the Echinoderms, still, as regards the structure and different modifications of the ventral excretory apparatus, they agree more closely with the *Trematoda* or flukes.

"Researches on the Structure, Physiology, and Development of *Antedon* (*Comatula*, Lamk.) *rosaceus*." By Dr. W. B. Carpenter, F.R.S.

The author, after adverting to the special interest attaching to the study of this typical form, as the only one readily accessible for the elucidation of the life-history of the Crinoidea, states it to be his object to give as complete an account as his prolonged study of it enables him to offer, of its minute structure, living actions, and developmental history, taking up the last at the point to which it has been brought in the memoir of Prof. Wyville Thomson.

He prefaces his memoir with an historical summary of the progress of our knowledge of the distinctive peculiarities of this genus, and of its relation to the Crinoidea; and he shows that the first recognition of this relationship was most distinctly made by Llhuyd, at the beginning of the last century, though that recognition has been passed without notice by most subsequent writers, and is altogether ignored by MM. de Koninck and le Hon in their recent history.

The author then proceeds to describe the external characters of *Antedon rosaceus*; and shows, from its habits as observed in a vivarium, that although possessed of locomotive power, it makes so little use of this under ordinary circumstances, that its life in the adult condition, no less than in its earlier stage, is essentially that of a pedunculate Crinoid.

He then gives a minute description of the several pieces of the skeleton—the accounts of these previously given by J. S. Miller and Prof. Joh. Müller not being in sufficient detail to serve as standards of comparison to which the parts of fossil Crinoids may be

referred. And he directs special attention to the curiously inflected rosette-like plate, previously unnoticed, which occupies the central space left within the annulus formed by the adhesion of the first radials. This plate is in special relation to the organ termed by Joh. Müller the "heart," but certainly having no proper claim to that designation, being a quinquepartite cavity in the central axis, from the walls of which there pass out not vessels but solid cords of sarcode, into the rays and arms, and also into the dorsal cirri. The inflexions of the rosette-like plate serve for the support and protection of the large cords passing into the rays, each of which has a double origin, and a connexion with the adjacent radiating cords that reminds the anatomist of the "circle of Willis."

The skeleton of the adult differs so widely in the forms and relations of its parts from that of the early Pentacrinoid larva described by Prof. Wyville Thomson, that the derivation of the former from the latter can only be understood by observation of all the intermediate stages. When the calcareous skeleton of the calyx first shows itself, it consists only of five *oral* plates arranged conformably upon five *basal* plates, as thus:—

O O O O O
B B B B B

At a stage a little more advanced (which has been described by Prof. Allman, Trans. Roy. Soc. Ed. vol. xxiii. p. 241), the rudiments of the *first radials* are found interposed between the orals and basals, alternating in position with both, as in the margin; and between two of these first radials there appears a single small unsymmetrical plate, which afterwards proves to be the *anal*. The first radials undergo a rapid increase in size, and soon become surmounted by *second* and *third* radials, which project between the orals; whilst the orals and basals, undergoing no such increase, are relatively very much smaller; the *anal* plate is still found on the line of the first radials. But from this time the radials form the principal part of the calyx, which opens out widely in conformity with the increase of space required for the digestive apparatus, the intestinal canal being now developed around what was originally a simple stomach with one orifice. The highest joint of the stem also undergoes a remarkable increase in size, and begins to acquire the form of a basin with an inflected rim, constituting what is known in the adult as the *centro-dorsal* piece. When the calyx opens out, the five *oral* plates, which originally formed a circlet around the mouth, retain that position, and detach themselves entirely from the divergent radials, nothing but the soft perisomatic membrane filling up the space between them. These *oral* plates never increase in size, and towards the end of the Pentacrinoid stage

O O O O O
a a a a a
B B B B B

A^3 A^3 A^3 A^3 A^3
A^2 A^2 A^2 A^2 A^2
O O O O O
A^1 A^1 an A^1 A^1 A^1
B $\overline{B}$ B B B

they begin to undergo absorption. I can still trace their basal portions in young specimens of the free *Antedon*; but as the creature advances towards maturity they are altogether lost sight of. When the intestinal canal has been sufficiently developed to open on the surface of the oral disk, the *anal* plate is lifted out of the position it originally occupied, and is at last found on the anal funnel, far removed from the radials. This, like the oral plates, begins to undergo absorption towards the end of the crinoidal stage, and completely disappears in the early part of the life of the free Antedon. The *radial* plates increase not only in size but also in thickness; and channels which are left on their internal surface by vacuities in the calcareous network, are converted into canals by a further inward growth of this, which completely covers them in. It is through these canals that the cords of sarcode pass to the arms. The *basal* plates, like the oral, remain stationary in point of size, and present no change in appearance or position until after they have been completely concealed externally by the centro-dorsal piece (the highest joint of the stem), which rapidly augments, both in absolute and in proportional size, when the development of the dorsal cirri is taking place from its convex surface. By the end of the Pentacrinoid stage, this plate has extended itself so far over the base of the calyx as completely to conceal the basals; and as the free *Antedon* advances towards maturity, it gradually extends itself over the first radials, which then become adherent to it and to each other. The basals then undergo a most curious metamorphosis, consisting in absorption in one part and extension in another, by which they finally become converted into five peculiarly shaped pieces, the ultimate union of which forms the single rosette-like plate which has been already stated to lie within the annulus formed by the first radials of the adult *Antedon*. Hence the calyx finally comes to be thus composed:—

$$\underbrace{\begin{matrix} R^3 & R^3 & R^3 & R^3 & R^3 \\ R^2 & R^2 & R^2 & R^2 & R^2 \end{matrix}}$$

$$\underbrace{b\ R^1\ b\ R^1\ b\ R^1\ b\ R^1\ b\ R^1}$$

CENTRO-DORSAL.

As the *orals* and the *anal* have entirely disappeared, no part of the primordial calyx of the Pentacrinoid larva is traceable in it, until we separate the adherent pieces which form its base, and search out the minute and delicate rosette-like plate which is formed by the metamorphosis of the *basals*.

The structure, physiology, and development of the digestive, circulatory, and respiratory apparatus, and of the nervous and muscular systems, will form the subject of a future memoir.